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Review of Multimodal Biometric Identification Using Hand Feature and Face

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Abstract

In the era of Information Technology, openness of the information is a major concern. As the confidentiality and integrity of the information is critically important, it has to be secured from unauthorized access. Security refers to prohibit some unauthorized persons from some important data or from some precious assets. So we need accurateness on automatic personal identification in various applications such as ATM, driving license, passports, citizen's card, cellular telephones, voter's ID card etc. Unimodal system carries some problems such as Noise in sensed data, Intra-class variations, Inter-class similarities, Non-universality and Spoof attacks. The accuracy of system is improved by combining different biometric traits which are called multimodal. This system gives more accuracy as it would be difficult for imposter to spoof multiple biometric traits simultaneously. This paper reviews different methods for fusion of biometric traits.

Keywords: *Unimodal, Multimodal, Fusion levels, Fusion methods*

1. Introduction

In addition to identification, security is equally important. The past methods of identification such as PIN, passwords etc. are unreliable, since there is possibility of frauds. Solution to such problem is given by using biometric identities. Biometric is Physiological (e.g., fingerprints, face, iris) and behavioral (e.g., speech) characteristics of person which is absolutely unique to it. Biometrics identifies the person by what the person is rather than what the person carries, unlike the conventional authorization systems like smart cards. Biometric identifiers cannot be misplaced, forgotten, guessed, or easily forged. Most biometric system used in real world are unimodal. Unimodal means identity of person is done by using single biometric trait. But this system carries some problems such as Noise in sensed data, Intra-class variations, Inter-class similarities, Non-universality and Spoof attacks. On the other hand, multimodal biometric system is biometric system that utilizes features from different biometric modalities and takes advantage of each of these biometric [1][2][3]. The accuracy of system is improved by combining different biometric. In multimodal system, when one biometric fails to recognize person, the other biometric can recognize the person successfully. In this paper, we will review how fusing of hand geometry, palmprint, fingerprint, and face can be done. Several types of biometric features can be extracted from hand images.

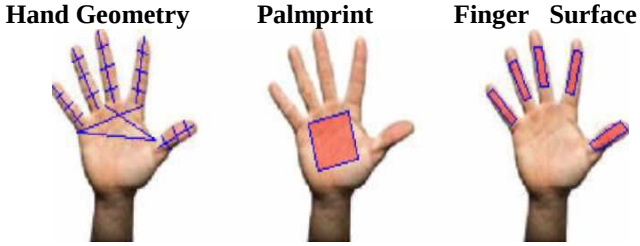

Figure 1. Hand features used as biometric identifiers

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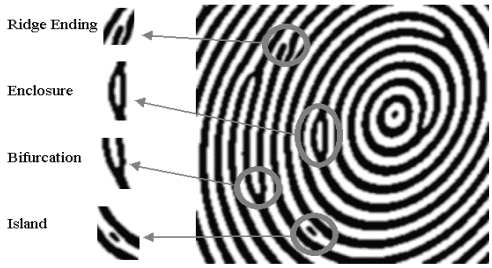

Figure 2. Minutiae points

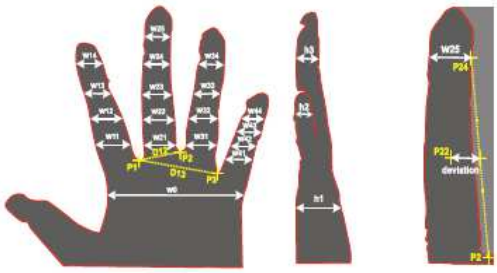

Figure 3. Geometrical Features of Hand

Fingerprint matching can be done by using minutiae based (ridge ending, ridge bifurcation points) and texture based. Hand geometry features, such as hand shapes, palm area, width and length of fingers are extracted. Palm print characteristics like principal lines, wrinkle, skin texture are extracted from palm print.

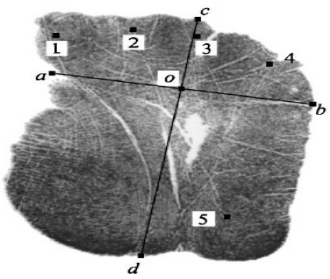

Figure 4.Palm print Characteristics

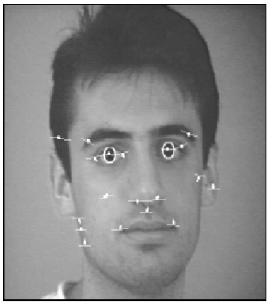

Figure 5. Salient regions of the facial image

2. Literature Survey

The biometric systems which are used for personal identification or verification are not new. From last two decades, researchers using these techniques. Nowadays, a wide variety of applications require reliable verification schemes to confirm the identity of an individual. For recognizing person with different biometric identities are used such as face, gait, fingerprint, palm print, Iris and signature [4].

W. Shu, D. Zhang presented a prototype system based on different palm print features, which are classified as geometrical, principal-line and wrinkle features, delta-point features and minutiae[8]. The researcher evaluated the FRR and FAR on different combinations of palm-print features. Their experiments showed that (FRR =0.0% and FAR = 0.2%).

Zhang et al. used two novel characteristics for their palm-print verification: there are datum point invariance and line feature matching [9]. The palm print verification with both datum point invariance and line feature matching were tested by 20 couples of palm print images from 20 right palms. Experimental results shows (FAR = 0.0% and FRR = 0.0%).

N. Duta, A. K. Jain, K. V. Mardia investigated the feasibility of person identification based on feature points extracted from palm-print images [10]. Their approach is based on a set of feature points extracted from along the principal lines and the associated line orientation. The overlap between the user (genuine) and the impostor distributions is reported by approximately 5%. J. You, W. Li, D. Zhang [11] proposed a texture-based, dynamic selection scheme to facilitate a fast search for the best matching of a palm-print template in the database in a hierarchical fashion. Han, Cheng and Lin, Fan proposes two techniques for the verification: the multiple-template matching method and the back propagation neural network method [12].

Golfarelli et al**.** [5] addressed the problem of performance evaluation in biometric verification systems. In one of two evaluated verification systems, they describe the prototype of a hand-based biometric system that takes into account 17 geometrical features of the hand. Sanches-Reillo et al. [6] defined and implemented a biometric system based on hand geometry which gives main distances and angles of the hand and divided into four different categories: width, heights, deviations, and angles between the inter-finger Points such Thirty-one features are extracted. Euclidean distance, Hamming distance, Gaussian Mixture Models (GMMs) and Radial Basis Function Neural Networks are used for the classification and verification. The best results – success rates approximately 96% – are obtained using a GMM. Jain et al. [7] also presented an authentication method based on the deformable matching of hand shapes. The verification decision is based on shape distance, which is automatically computed during the alignment stage. Shape distance proved to be a more reliable classification criterion than a handcrafted feature set. The proposed approach resulted in a 96.5% genuine-accept rate versus a 2% false-accept rate.

Wei Wang Jianwei Li Weimin Chen proposes minutiae based fingerprint identification system [14]. Here to improve the accuracy of minutiae matching, a global optimum alignment approach is developed, which is targeted on the alignment of a set of reference minutiae pairs. But it is affected by blur images. It depends on fingerprint shift and rotation**.** Jiong Zang, Jie Yuan, Fei Shi, Si-dan Du , proposes a novel point matching algorithm [15], which uses fingerprint reference point and reference direction to establish a polar coordinate system for representing feature information of fingerprints. Xudong Jiang and Wei-Yun Yau, proposes new fingerprint matching technique based on both the local and global structures of the fingerprint minutiae [16].

R. Brunelli and T. Poggio, proposes face recognition system which was performed by independently matching templates of three facial regions (eyes, nose and mouth) [17]. The configuration of the components during classification was unconstrained since the system did not include a geometrical model of the face. D J Beymer proposes face recognition using various poses of face [18]. L. Wiskott, J. Fellous, proposes a geometrical model of a face which was implemented by a 2D elastic graph [20]. The recognition was based on wavelet coefficients that were computed on the nodes of the elastic graph. In A. Nefian and M. Hayes**,** a window was shifted over the face image and the DCT coefficients computed within the window were fed into a 2D Hidden Markov Model [21]. LinLin Shen a, Li Bai a, Michael Fairhurst,proposes face recognition using gabor filter and general discriminate[19].

Most of the biometric systems used in real world applications are unimodal. These systems have problems such as noisy data, intra-class variations, inter-class similarities, non-universality and spoofing. It leads to considerably high false acceptance rate (FAR) and false rejection rate (FRR), limited discrimination capability, upper bound in performance and lack of permanence [1, 4]. Some strengths and weakness of biometric are summarize as Table 1.

Some of the limitations imposed by unimodal biometric systems can be overcome by using multimodal biometric system which uses more than one biometric identity. This system is more reliable due to the presence of multiple and independent biometrics. This system gives more accuracy as it would be difficult for imposter to spoof multiple biometric traits simultaneously [2,3]

Norhene, Alima and Dorra propose a multimodal biometric recognition system which combines two modalities: face and fingerprint [22]. Here for face trait features based on Gabor Wavelet Networks (GWNs), while Local Binary Patterns (LBP) is used for fingerprint trait. A weighted sum rule based fusion is used which achieves excellent recognition performances than single biometric systems. Yan Tong Frederick W and Wheeler Xiaoming Liu developed score-level multimodal fusion algorithms based on predictive quality metrics and employed them for the task of face and fingerprint biometric fusion [23]. Cheng Lu, Jisong Wang, Miao Qi, developed a multimodal biometric identification approach based on the features of face and palm print [24]. Here, two feature extraction methods are employed, one is based on the statistics properties (SP) of the biometric image and the other is the classic two dimensional principal components analysis (2DPCA). The minimal distance rule (MDR) is adopted for fusion at the matching score level. Sheetal Chaudhary and Rajender Nath propose a multimodal biometric recognition system integrating palmprint, fingerprint and face based on score level fusion [25]. Fan Yang and Baofeng Ma propose fusion of fingerprint, hand geometry, palm print using feature and match score together to establish identity [26].

Table 1. Strength weakness, usability of different biometric identities

Biometrics	Strengths	Weakness	Usability
Hand	1) Small template (approximately 10 bytes) 2) Low failure to enroll rate Unaffected by skin condition	Physical size of acquisition device Physical contact required Extra finger growth	Physical access control Time and attendance
Face	Few people object to have their photo taken, low cost	No real scientific validation	Physical access control
Palm print	Low resolution imaging Stable line Feature and remains constant throughout the life High user acceptance	Scar surgery	For medium security
Finger print	Most mature biometric technology Accepted reliability Small template (less than 500 bytes)	Physical contact required (a problem in some cultures) Hampered by temporary physical injury	IS access control Physical access control Automotive

3. Summary of Literature Survey

From literature survey above, it is found that the following fusion levels and fusion methodology are used by different researchers for accurate personal identification.

Table 2. Fusion levels and methodology

Modalities Fused	Authors	Level of Fusion	Fusion Methodology
Face, fingerprint and hand geometry	[25]	Match score	Sum rule
Face and palmprint	[24]	Match score	Minimum distance rule
	[27]	Match score	Sum,product,max,min,LDA rule
	[26]	Feature, Match score	Weighted sum rule
Fingerprint, hand geometry and palmprint	[28]	Feature, score, Fusion	Hamming distance, Thresholding
	[31]	Score, Decision	Euclidian Distance
Face and Fingerprint	[22]	Match score	Weighted sum rule
	[30]	Match score	Product Rule
Fingerprint and Palmprint	[29]	Match score	NN classifier and thresholding

4. Multimodal Biometrics

4.1. Levels of Fusion

In multimodal biometric different fusion strategies are used as follows:

a) Fusion at the feature-extraction level, where the features extracted using two or more sensors are concatenated.
b) Fusion at the matching-score level, where the matching scores obtained from multiple matchers are combined.
c) Fusion at the decision level, where the accepted or rejected decisions of multiple systems are consolidated.

Biometric system which integrate information at early stages are more effective than those integrate at match score or decision level because of rich information is available at early stages. But the disadvantage of this fusion that size of database increases and some modalities are not fused as their feature set are not compatible e.g. minutiae pt. of fingerprint and Eigen values of face fusion at decision level is rigid as limited information available. So preferably fusion at match score level is used as it is easy to access and combine scores.

4.2. Fusion Scenarios

Multimodal biometric systems can be designed to operate in five integration scenarios:

a) *Multiple sensors*- where output from different sensors are combined
b) *Multiple instances* – combine different instances of the same biometric trait (e.g., left and right iris)
c) *Multiple samples* – combine different samples of the same biometric trait (e.g., two impressions of a person's right index finger)
d) *Multiple biometric traits*- combines different biometric traits (e.g., face and fingerprint)

e) *Multiple representations and matching algorithms for the same biometric*- combines different algorithm for e.g. texture based and minutiae based fingerprint matcher are combined [3].

4.3. Modes of Operation

Multimodal can operate in three different modes. It is in serial, parallel, and hierarchical. In serial mode output of one modalities is connected to other modalities e.g. multiple traits, where information is acquired from different modalities separately. In parallel mode, information from different modalities is acquired simultaneously for recognition. In hierarchical, it is combination of serial and parallel mode.

5. Conclusion

Fusion of different modalities based on Fusion levels, Fusion scenarios, and modes of operation. Integrating multiple biometric traits improves recognition performance and reduces fraudulent access. Multimodal is new area of research. Due to significance of multimodal, lot of researcher attracted towards this field so there is lot of scope for research in this field.

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